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ALUMINUM COMPANY OF AMERICA,
Alcoa Research Laboratories.
Chemical Metallurgy Division
New Kensington, Pennsylvania
Pa.

t: INVESTIGATION OF THE STRESS-CORROSION CRACKING OF HIGH-STRENGTH ALUMINUM ALLOYS. Quarterly ... no. 1, for Period ...

Contract Number - NAS 8-5340
Control Number - TP3-85210 and S1(1f)
CPB 02-1094-63

First Quarterly Report
(Period of May 6 to July 31, 1963, inclusive)

Reported by B. W. Lifka
B. W. Lifka / 13 Aug. 1963 27 refs

Approved by D. O. Sprowls
D. O. Sprowls

NASA Contract NAS 8-5340
NASA CR-55077

August 13, 1963

ALUMINUM COMPANY OF AMERICA
Alcoa Research Laboratories
Chemical Metallurgy Division
New Kensington, Pennsylvania

SYNOPSIS:

The required literature survey has been completed and separately reported. Fourteen surface treatments have been suggested for evaluation, of which thirteen have been approved by the contracting officer and one is pending.

A detailed outline of the experimental program has been made and is contained herein.

Satisfactory control test results have been obtained on all eleven aluminum alloy materials and all have been accepted for contract usage. Specimen procurement is continuing and alternate immersion tests have been initiated on 1/8" dia., as-machined specimens from ten of the alloys.

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OBJECTIVES:

The objectives of this investigation are to investigate the stress-corrosion characteristics of high-strength aluminum alloys with specific emphasis directed towards:

(1) Evaluating various potentially useful surface treatments and protective coatings to prevent stress-corrosion cracking of susceptible materials.

(2) Comparing relative resistance to stress-corrosion cracking of various commercial high-strength aluminum alloys and tempers.

(3) Investigate the mechanism of stress-corrosion cracking of high-strength aluminum alloys.

WORK PROGRESS:

Current Report Period (May 6 to July 31, 1963)

During the first three months of the contract, a total of 1077.5 man-hours were expended (165 in May, 376 in June and 536.5 in July). This time was spent on:

1. the required literature survey
2. procurement of and control tests on the eleven different alloys involved.
3. test specimen procurement
4. design modifications and test cell construction for the mechanism study.
5. preparation of specimens for exposure
6. initiation of alternate immersion tests on uncoated 1/8" diameter tensile bars.

A more detailed description of the preceding work follows:

(1) Literature Survey

The literature search was completed and a report transmitted on June 21, 1963, along with a list of 14 protective treatments recommended for evaluation. Approval has been obtained on thirteen treatments and the necessary materials are being procurred. The one treatment still indefinite, is the hard anodic coating. The modified Alumilite 226 Process and the Martin Hard Coat Process (both of which are similar) are being considered. Alcoa favors the former as it has been given more commercial usage. The 14 treatments are listed in Attachment A, and more specific details as to reasons for these selections and the methods of application can be found in the Literature Survey Report (Reference 1).

(2) Alloy Procurement and Control Tests

All eleven rod items have now been received and satisfactory control test data obtained on each of them. All eleven items, have therefore, been accepted for contract usage. The control test data are given in Table I. All eleven have a chemical composition that is within the limits specified by the Aluminum Association and have typical longitudinal tensile properties.

Initially, two of the items received, 7075-T7351 and 2219-T62, had somewhat marginal tensile properties.

The 7075-T7351 item was removed from the contract and new, satisfactory material obtained from the mill. Since the -T62 temper of 2219 alloy designates customer heat treatment, it does not require use of plant heat treat equipment. Half of the material received was, therefore, re-heat treated at ARL, using standard practices and the resultant properties were satisfactory. Contract work on 2219-T62 will be limited to the portion re-heat treated at ARL.

Solution potentials and electrical conductivities were obtained on alloys for which results are significant. Values obtained, indicated proper artificial aging in all cases.

Pitting was found to be the predominant type of attack in all but the 2024-T351 item for which a mixture of pitting and intergranular attack was observed. However, in view of the section size, the degree of intergranular attack cannot be considered excessive and it was concluded that all items had been properly heat treated.

(3) Specimen Procurement

The various types of specimens being employed, plus the loading devices for stressed specimens are shown in Figures 1 to 6. The 1/8" diameter tensile bars have been procured from all but the 7075-T7351 rod, which was the last item to be received. The 1/2" dia. bars have been prepared from four of the six alloys involved and approximately 70% the required O-ring specimens have been machined. The interferences required for these rings are being calculated and stressing plugs obtained.

The special thermal treatments planned for the mechanism study have been completed. However, none of the torsion specimens have as yet been machined because it was decided that the number of specimens justified the use of a template to insure maximum dimensional reproducibility. The required template has been made.

(4) Mechanism Study

The necessary modifications in specimens size to permit transverse testing and design of a corrosion test cell have been completed. The specimen type is shown in Figures 1d and 6. Construction of the test cell is still in progress and photographs will be obtained when it is completed.

Basically, the scope of this mechanism phase of the contract is a time-potential study on specimens being twisted to fracture in an electrolyte. These tests will be conducted in the Vertical Torsion Testing Equipment (Reference 2) which is a specially constructed machine, instrumented to provide autographic records of torque versus total angle of twist. The machine can be operated at various twist rates and at torques up to 1500 in.-lb. Solution potential measurements will be made with respect to a saturated calomel reference electrode, recorded on an auxiliary Autograph.

Two alloys, 2024 and 7075 have been selected for test. In addition to the standard mill tempers (2024-T351

and -T851 and 7075-T651 and -T73) intermediate tempers with varying degrees of susceptibility to stress-corrosion cracking will be tested. Initial tests will be conducted in 3.5% NaCl solution at the slowest twist rate of 0.029 rpm. The effect of twist rate and at least one other electrolyte will be evaluated. Tentative plans are to investigate four tempers of each alloy, two electrolytes, two twist rates on at least one alloy or both if necessary, with quintuplicate specimens for each test condition. This represents either 120 or 160 specimens and should be within the alloted 15% portion of total contract effort. This tentative plan is subject to change depending on the initial test results.

(5) Determination of Relative Resistance To Stress-Corrosion Cracking

All eleven alloys are involved in this phase. The 1/8" diameter specimen to be employed is shown in Figures 1a and 2. The specimen is uniformly stressed in direct tension by means of ARL's stressing frame, Figure 3.

The scope of the tests to be conducted is shown in Table II. Specimens received to date have been submitted for determination of original properties and preparation for alternate immersion exposure. Table IV is a copy of a work table showing the tensile properties, initiation dates for the various alloys and the exposure time of failures that have occurred. A blank spot in the table means the data have not as yet been obtained. This table will be completed as the test progresses.

(6) Evaluation of Protective Treatments

Six alloys are involved in this phase. Unstressed specimens are 1/2" diameter bars (Figures 1c and 4) while 2-1/4" O.D. by 1/8" wall rings (Figures 1b and 5) are being used for the stressed specimen. The rings will be stressed by forcing them over an interference fit plug, also shown in Figure 5. The scope of the tests is outlined in Table III. The original properties have been determined for four alloys and are listed in Table V.

FUTURE WORK:

Overall Plan

A schematic of the overall estimated program schedule is attached in Figure 7. This is the same schematic that was submitted at the end of the second month. Two machinists have been assigned to this contract on a full-time basis and the machining work should be completed by the indicated dates or earlier.

At the moment, the only thing which might delay the rest of the scheduling is late procurement of the paints required, most of which are not on hand in the quantity required. These materials have been ordered and it is believed they will be available by September 1, the target date for inception of coating operations.

Next Report Period (August 1 to August 31, 1963)

During the month of August, 1963, the following work is anticipated:

I - Mechanism Study

(1) complete construction of test cell and specimen procurement.

(2) pending completion of test cell, photograph cell and conduct qualifying and calibration test runs, particularly with regard to twist rate and electrolyte.

II - Stress Corrosion Tests

A - 1/8" Diameter Test Bars

(1) complete specimen procurement, determination of properties and initiation of alternate immersion tests.

(2) select stress levels for other environments and begin preparation of specimens for test.

B - 1/2" Diameter Test Bars and O-Rings

(1) complete specimen procurement and determination of original properties.

(2) as specimens are received, submit for measurement of original dimensions, calculate required plug interferences, complete plug procurement and stress rings.

(3) submit specimens for peening and metallizing

(4) procure necessary materials for various coatings.

REFERENCES:

(1) NAS 8-5340 Re: Investigation Of The Stress-Corrosion Cracking Of High-Strength Aluminum Alloys, Literature Survey by D. G. Vandenburgh and R. Rolles, dated 6-21-63.

(2) D. S. Fields and W. A. Backofen, Proc. Amer. Soc. Test Mat., 1957, 57, 1259.

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Mr. R. Rolles
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ATTACHMENT A

System No.	System
1	As Machine - control
2	Shot peened
3	Metallized with 7072 aluminum alloy (3 to 4 mil)
4	Zinc electroplate (3 to 4 mil)
5	Alumilite 205 (0.2 mil)
6	Either Modified Alumilite 226 or Martin Hard Coat (2 mil) (final selection to be made by contracting officer)
7	Alodine 1200 + Zinc Chromate Primer (0.5 mil)
8	Alodine 1200 + Epoxy-Polyamide (2 mil)
9	Alodine 1200 + Strontium Chromate Epoxy Primer (1 mil) + Epoxy-Polyamide (2 mil)
10	Alodine 1200 + Strontium Chromate Epoxy Primer (1 mil) + Epoxy-Polyamide Vehicle with added Aluminum Pigment (1 mil) + Epoxy-Polyamide (2 mil).
11	Alodine 1200 + Polyurethane Pigmented with Titanium Dioxide (2 mil)
12	Alodine 1200 + Strontium Chromate Epoxy Primer (1 mil) + Polyurethane Pigmented with Titanium Dioxide (2 mil)
13	Zinc-Rich Paint (Epoxy-Polyamide Pigmented with Zinc (3 mil)
14	Shot Peened + Alodine 1200 + Strontium Chromate Epoxy Primer (1 mil) + Epoxy-Polyamide (2 mil)
15	Metallized with 7072 Aluminum Alloy (3 to 4 mil)+ Alodine 1200 + Strontium Chromate Epoxy Primer (1 mil) + Epoxy-Polyamide (2 mil).

TABLE I

CONTROL TEST DATA OBTAINED ON NINE ITEMS OF
2-1/2" DIA. ROLLED ROD RECEIVED AS OF 6-30-63

Alloy	Composition - Per Cent (1)											
	Cu	Fe	Si	Mn	Mg	Zn	Ni	Cr	Ti	Be	Zr	V
2014-T651	4.41	.26	.88	.82	0.57	0.04	.01	.01	.02	-	-	-
2024-T351, -T851(2)	4.54	.22	.11	.57	1.57	0.02	.00	.00	.03	.000	-	-
2219-T62, -T851, -T87(2)	6.28	.18	.11	.29	0.01	0.03	.02	.01	.06	-	.17	.10
X7006-T651	0.05	.14	.06	.20	2.11	3.99	.00	.11	.05	.000	-	-
7079-T651	0.64	.23	.10	.20	3.48	4.59	.01	.15	.03	.001	-	-
7075-T651	1.61	.19	.10	.02	2.50	5.86	.00	.19	.05	.001	-	-
7075-T7351	1.54	.21	.10	.02	2.35	5.68	.00	.19	.04	.001	-	-
7178-T651	1.97	.16	.10	.02	2.60	6.72	.00	.20	.01	.001	-	-

Alloy	Longitudinal Properties (3)			Solution Potential(4)	Electrical Conductivity	Type of Attack (MIL-H-6088)(5)	
	T.S.(ksi)	Y.S.(ksi)	El.(% in 4D)	-mv	%IACS	Surface	Interior
2014-T651	69.5	64.0	11.0	792	--	P	P
2024-T351	64.3	47.9	22.5	700	--	I + P	P + I
2024-T851	67.5	62.0	10.5	828	--	P	P
2219-T62	60.5	41.0	11.0	806	--	P	P
2219-T851	64.5	47.5	12.0	812	--	P	P
2219-T87	67.0	55.0	13.0	792	--	P + SI	P
X7006-T651	64.9	59.5	16.0	-	--	P	P
7079-T651	78.1	73.4	12.0	-	--	P	P
7075-T651	84.2	77.5	13.3	-	32.0	P	P
7075-T7351	76.6	68.0	13.2	-	40.6	P	P
7178-T651	92.4	85.5	11.0	-	33.2	P	P

NOTES: (1) Obtained Quantometrically on Cast Disk Samples.
(2) Originated from same ingot source.
(3) Obtained at fabricating works using 1/2" dia. bars taken midway between surface and center, parallel to the rolling direction.
(4) Average steady potential value in NaCl-H_2O_2 solution, referred to 0.1N calomel cell at 25°C (for most alloy steady, state is reached within 1/2 hr.).
(5) P = Pitting, SI = Slight Intergranular, I = Intergranular

Table II

STRESS CORROSION TEST SCHEDULE FOR UNPROTECTED SPECIMENS
TRANSVERSE 1/8" DIA. TENSILE BARS, REFERENCE FIGURES 1 & 2

Alloy	Orig. Prop. No. of Specs.	Corrosion Tests - Number of Specimens Per Environment										Total Specs.
		A.I.		P.C.		P.J.		N.K.		Accel.		
		Unst.	Str.	Unst.	Str.	Unst.	Str.	Unst.	Str.	Unst.	Str.	
2014-T651	3	5	10	5	10	5	10	5	10	-	-	63
2024-T351	3	5	10	-	-	-	-	-	-	-	-	18
2024-T851	3	5	5	-	-	-	-	-	-	-	-	13
2219-T62	3	5	5	-	-	-	-	-	-	-	-	13
2219-T851	3	5	5	-	-	-	-	-	-	-	-	13
2219-T87	3	5	5	5	5	5	5	5	5	-	-	43
X7006-T651	3	5	10	5	10	5	10	5	10	5	10	78
7079-T651	3	5	10	5	10	5	10	5	10	5	10	78
7075-T651	3	5	10	-	-	-	-	-	-	-	-	18
7075-T73	3	5	5	5	5	5	5	5	5	-	-	43
7178-T651	3	5	10	5	10	5	10	5	10	-	-	63
Total	33	55	85	30	50	30	50	30	50	10	20	428

Environment	Exposure Periods
A.I. = 3.5% NaCl - Alternate Immersion	unstressed - 1, 2, 4, 8 and 12 weeks stressed - to failure or 12 weeks
P.C. = Point Comfort, Texas, Seacoast Atmosphere P.J. = Point Judith, R.I., Seacoast Atmosphere N.K. = New Kensington, Pa., Industrial Atmosphere	unstressed - 1, 2, 4, 8 and 12 months stressed - to failure or 1 year
Accel. = New Accelerated Test	unstressed - to be decided stressed - to be decided

Alloy	Stress Level for A.I. & Accel.(*)
2014-T651, 2024-T351, 7075-T651 and 7178-T651	duplicate specimens at 10, 15, 20 and 25 ksi + 2 pending
7079-T651	duplicate specimens at 15, 20 and 25 ksi + 4 pending
2024-T851, 2219-T62, 2219-T851 and 2219-T87	triplicate specimens at 75% transverse Y.S. + 2 pending
7075-T73	triplicate specimens at 75% guaranteed longitudinal Y.S. + 2 pending
X7006-T651	duplicate specimens at 75,50 and 25% transverse Y.S. + 4 pending

NOTE: (*) Two or four specimens held in reserve for optimum S.C.C. threshold stress level based on results of initial exposures.

All specimens for a particular atmosphere to be exposed simultaneously at optimum stress levels based on laboratory test results available at the time of exposure.

Table III

STRESS CORROSION TEST SCHEDULE FOR PROTECTED SPECIMENS
NUMBER OF SPECIMENS PER SURFACE TREATMENT PER ENVIRONMENT
Unstressed = 1/2" Dia. Longitudinal Tensile Bar (Figures 1 & 3)
Stressed 75% Y.S. = 2-1/4" O.D. x 1/8" Wall Transverse Ring (Figures 1 & 4)

Alloy	Original Properties		3.5% NaCl Alternate Immersion		Seacoast Atmosphere Point Comfort, Texas		Seacoast Atmosphere Point Judith, R.I.		Industrial Atmosphere New Ken., Pa.		Total For 15 Treatments(1)	
	Bars	Rings	0	75% Y.S.	0	75% Y.S.	0	75% Y.S.	0	75% Y.S.	Bars	Rings
2014-T651	3	5	3	5	3	10*	3	5	3	10*	183	455
2024-T351	3	5	3	5	-	-	-	-	-	-	48	80
2219-T87**	3	5	3	5	3	5	-	-	-	-	93	15
7075-T73**	3	5	3	5	3	5	-	-	-	-	93	15
7079-T651	3	5	3	5	3	10*	3	5	3	10*	183	455
7178-T651	3	5	3	5	-	-	-	-	-	-	48	80
Sub Total 1 Treatment	18	30	18	30	12	30	6	10	6	20	--	--
Total 15 Treatments	18	30	270	310	180	310	90	150	90	300	648	1100

Notes: (1) Consists of 1 set of unprotected control specimens plus 14 sets of protected specimens.
(*) Includes 5 additional specimens with intentionally damaged coatings.
(**) Stressed Ring Specimens exposed only in unprotected condition.

TABLE IV

ORIGINAL TENSILE PROPERTIES AND STRESS CORROSION DATA ON TRANSVERSE 1/8" DIA. BARS

Alloy & Temper	ARL S-No.	Original Transverse Properties				(1963)	3.5 Per Cent NaCl - Alternate Immersion							
							Unstressed				Stressed - To Failure or 12 Weeks			
		Dash No.	T.S. (ksi)	Y.S. (ksi)	El. (% In 4D)	In Date	Dash No.	Exposure (weeks)	% Loss In Prop. T.S.	% Loss In Prop. El.	Stress (ksi)	Dash No.	Days To Fail	% Loss In Prop. T.S.	% Loss In Prop. El.
2014-T651	302309	T1	69.7	61.5	6.0	7-30	T4	1			10	T9			
		T2	69.3	61.0	6.0		T5	2				T10			
		T3	70.0	60.6	7.0		T6	4			15	T11			
							T7	8				T12			
		AVG.	69.7	61.0	6.3		T8	12			20	T13			
												T14			
											25	T15			
												T16			
											(1)	T17			
												T18			
2024-T351	302210	T1	61.6	40.5	13.0	7-2	T4	1			10	T9	5		
		T2	64.9	41.5	17.0		T5	2				T10	18		
		T3	63.4	40.3	16.0		T6	4			15	T11	5		
							T7	8				T12	4		
		AVG.	63.3	40.8	15.3		T8	12			20	T13	3		
												T14	2		
											25	T15	3		
												T16	1		
											(1)	T17			
												T18			
2024-T851	302211	T1	65.7	59.0	6.0	7-2	T4	1			44(2)	T9			
		T2	64.0	58.2	6.0		T5	2				T10			
		T3	63.7	58.0	6.0		T6	4				T11			
							T7	8			(1)	T12			
		AVG.	64.5	58.4	6.0		T8	12				T13			
2219-T62	302482	T1	60.8	41.5	6.0	7-19	T4	1			31(2)	T9			
		T2	59.5	40.6	6.0		T5	2				T10			
		T3	59.8	40.2	6.0		T6	4				T11			
							T7	8			(1)	T12			
		AVG.	60.0	40.8	6.0		T8	12				T13			
2219-T851	302307	T1	63.9	45.9	8.0	7-30	T4	1			35(2)	T9			
		T2	64.0	45.9	6.0		T5	2				T10			
		T3	63.9	48.4	6.0		T6	4				T11			
							T7	8			(1)	T12			
		AVG.	63.9	46.7	6.7		T8	12				T13			
2219-T87	302353	T1	64.1	51.2	10.0	7-31	T4	1			39(2)	T9			
		T2	67.3	53.7	9.0		T5	2				T10			
		T3	66.4	52.5	10.0		T6	4				T11			
							T7	8			(1)	T12			
		AVG.	65.9	52.5	9.7		T8	12				T13			

(CON'T)

TABLE IV (CON'T)

Alloy & Temper	ARL S-No.	Original Transverse Properties: Dash No.	T.S. (ksi)	Y.S. (ksi)	El. (% In 4D)	(1963) In Date	3.5 Per Cent NaCl - Alternate Immersion: Unstressed: Dash No.	Exposure (weeks)	% Loss In Prop. T.S.	% Loss In Prop. El.	Stressed - To Failure or 12 Weeks: Stress (ksi)	Dash No.	Days To Fail	% Loss In Prop. T.S.	% Loss In Prop. El.
X7006-T651	302507	T1	Faulty Specimen				T4	1			13(4)	T9			
		T2	61.9	53.1	10.0		T5	2				T10			
		T3	61.3	52.0	9.0		T6	4			26(3)	T11			
							T7	8				T12			
		AVG.	61.6	52.6	9.5		T8	12			40(2)	T13			
												T14			
											(1)	T15			
												T16			
												T17			
												T18			
7079-T651	302354	T1	75.2	-	8.0	7-30	T4	1			15	T9			
		T2	77.3	66.4	8.0		T5	2				T10			
		T3	79.5	67.2	8.0		T6	4			20	T11			
							T7	8				T12			
		AVG.	77.3	66.8	8.0		T8	12			25	T13			
												T14			
											(1)	T15			
												T16			
												T17			
												T18			
7075-T651	302212	T1	84.3	70.2	9.0	7-2	T4	1			10	T9			
		T2	83.5	71.0	9.0		T5	2				T10			
		T3	81.0	69.9	8.0		T6	4			15	T11			
							T7	8				T12			
		AVG.	82.9	70.4	8.7		T8	12			20	T13	27		
												T14			
											25	T15	4		
												T16	4		
											(1)	T17			
												T18			
7075-T7351	302599	T1					T4	1			42(5)	T9			
		T2					T5	2				T10			
		T3					T6	4				T11			
							T7	8			(1)	T12			
		AVG.					T8	12				T13			

(CON'T)

TABLE IV (CON'T)

Alloy & Temper	ARL S-No.	Original Transverse Properties (1963) Dash No.	T.S. (ksi)	Y.S. (ksi)	El. (% In 4D)	In Date	3.5 Per Cent NaCl - Alternate Immersion Unstressed Dash No.	Exposure (weeks)	% Loss In Prop. T.S.	% Loss In Prop. El.	Stressed - To Failure or 12 Weeks Stress (ksi)	Dash No.	Days To Fail	% Loss In Prop. T.S.	% Loss In Prop. El.
7178-T651	302308	T1	82.9	73.4	6.0	7-30	T4	1			10	T9			
		T2	83.2	73.0	7.0		T5	2				T10			
		T3	82.9	73.4	5.0		T6	4			15	T11			
							T7	8				T12			
		AVG.	83.0	73.3	6.0		T8	12			20	T13			
												T14			
											25	T15			
												T16			
											(1)	T17			
												T18			

NOTES: (1) Specimens withheld from test pending results at above stress levels.

(2) Equals 75% of actual transverse yield strength.

(3) Equals 50% of actual transverse yield strength.

(4) Equals 25% of actual transverse yield strength.

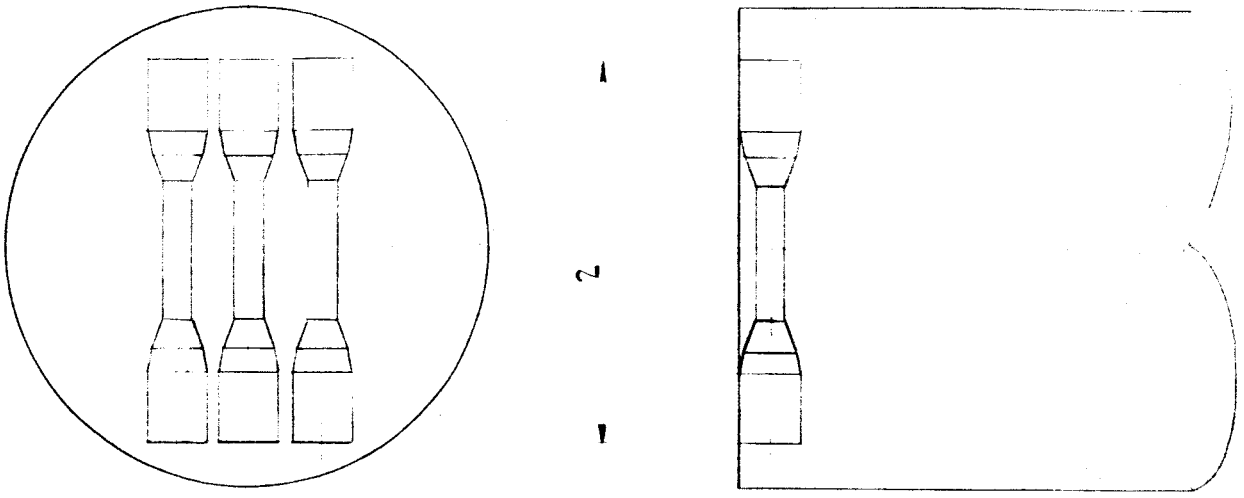
(5) Equals 75% of guaranteed longitudinal yield strength.

TABLE V

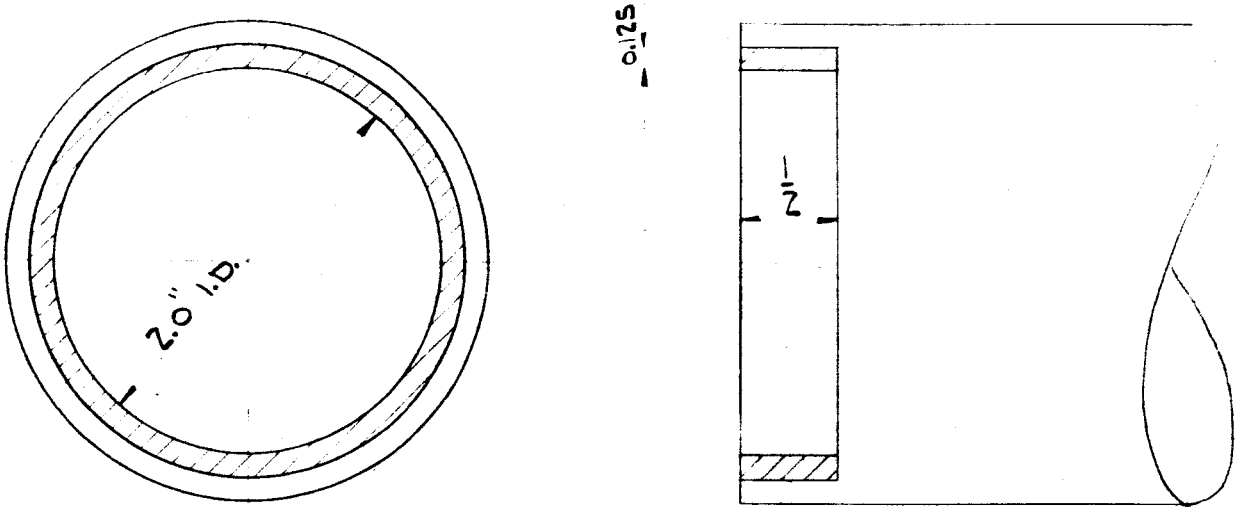
ORIGINAL TENSILE PROPERTIES (*)
LONGITUDINAL 1/2" DIA. BARS

Alloy & Temper	ARL S-No.	Dash No.	T.S. (ksi)	Y.S. (ksi)	El. (% In 4D)	Reduction Of Area (%)
2014-T651	302309	L1	67.6	62.3	10.5	27
		L2	69.1	64.0	13.0	30
		L3	70.0	65.1	12.5	29
		AVG.	68.9	63.8	12.0	28.7
2024-T351	302310	L1	65.3	48.7	22.0	28
		L2	65.8	48.6	22.0	29
		L3	65.4	48.6	21.5	30
		AVG.	65.5	48.6	21.8	29
2219-T87	302353	L1				
		L2				
		L3				
		A				
		AVG.				
7075-T7351	302599	L1				
		L2				
		L3				
		AVG.				
7079-T651	302354	L1	79.0	72.7	13.0	26
		L2	78.1	71.8	12.5	25
		L3	78.3	72.0	13.0	26
		AVG.	78.5	72.2	12.8	26.7
7178-T651	302308	L1	86.6	80.3	12.5	23
		L2	85.8	79.6	13.0	24
		L3	85.9	79.8	13.0	23
		AVG.	86.1	79.9	12.8	23.3

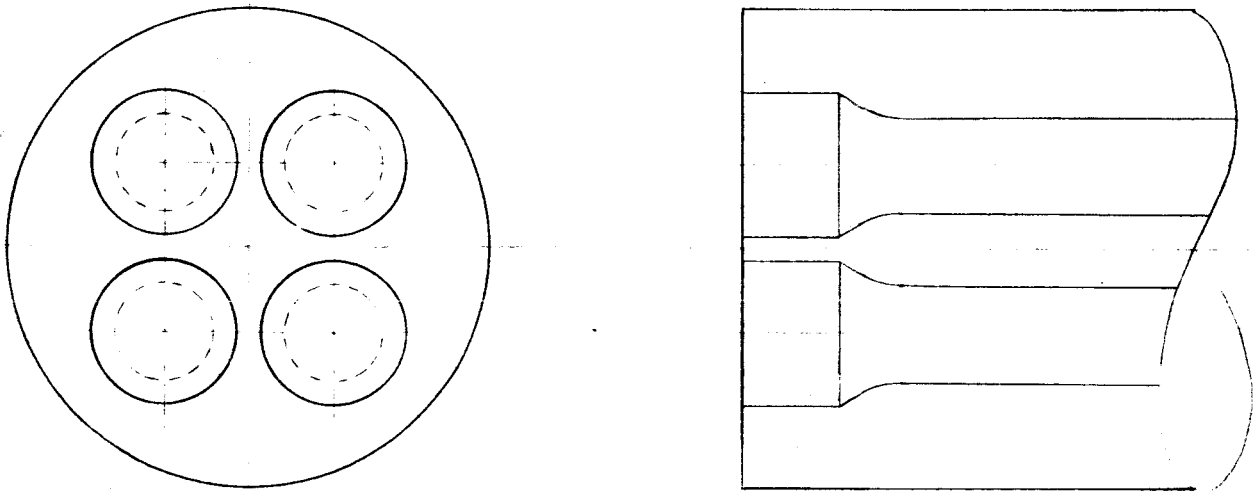
NOTES: (*) Subsequently to be compared with data obtained on specimens exposed according to the schedule in Table III for determination of per cent loss in tensile strength and elongation due to corrosion.



(a) 0.125 DIA. x 2" LG. TENSILE TEST SPECIMEN



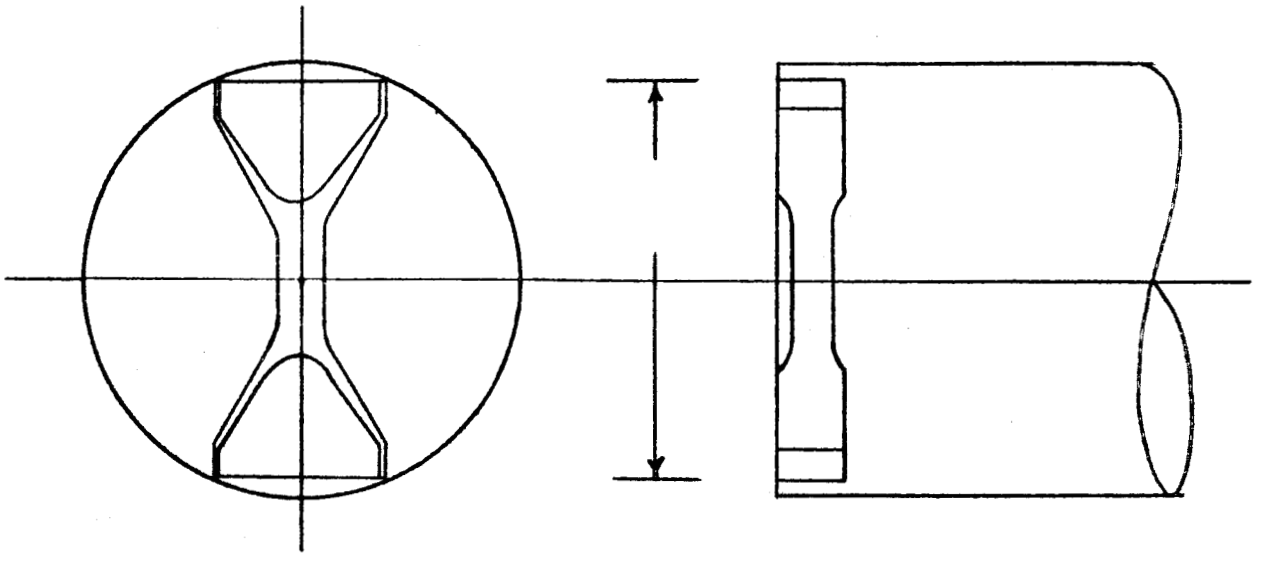
(b) 2.25" O.D. x 0.125" WALL RING



(c) 0.500" DIA. TAPERED SEAT TENSILE TEST SPECIMEN

FIGURE-1

LOCATION OF TEST SPECIMENS IN 2½" DIA. ROLLED ROD STOCK

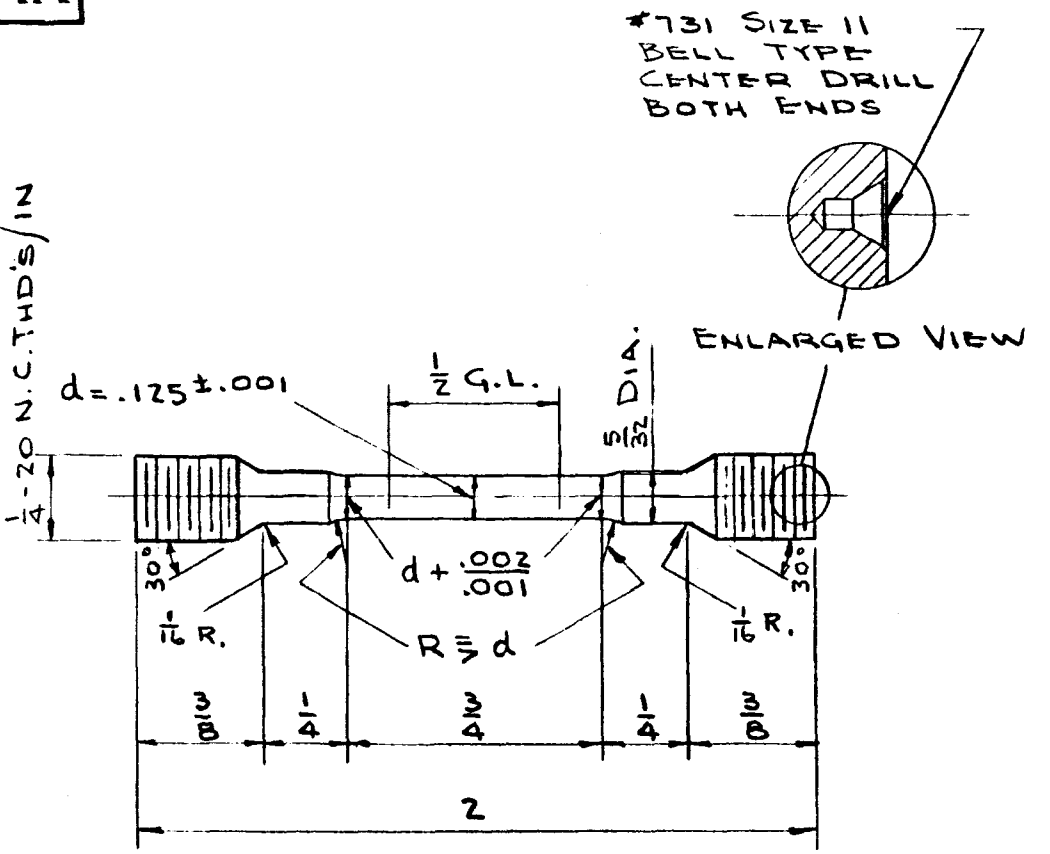


(d) 0.250" Dia. Torsion Specimen

Figure 1 (con't)

LOCATION OF TEST SPECIMENS IN 2-1/2" DIA.
ROLLED ROD STOCK

L-7034-RK



SPECIMEN —— [ ] REQ'D

f.a.o. 63 micro-inches

MACHINING SETUP	D-6996-RK
TOOL BIT	D-7647-RK
CENTER & FACE TOOL	D-7444-RK
TEMPLATE	D-6989-RK
DRIVER	D-6981-RK

DATE	NO.	REVISION RECORD	DR	CK
1-15-58		SUPERSEDES B-2276-RK		

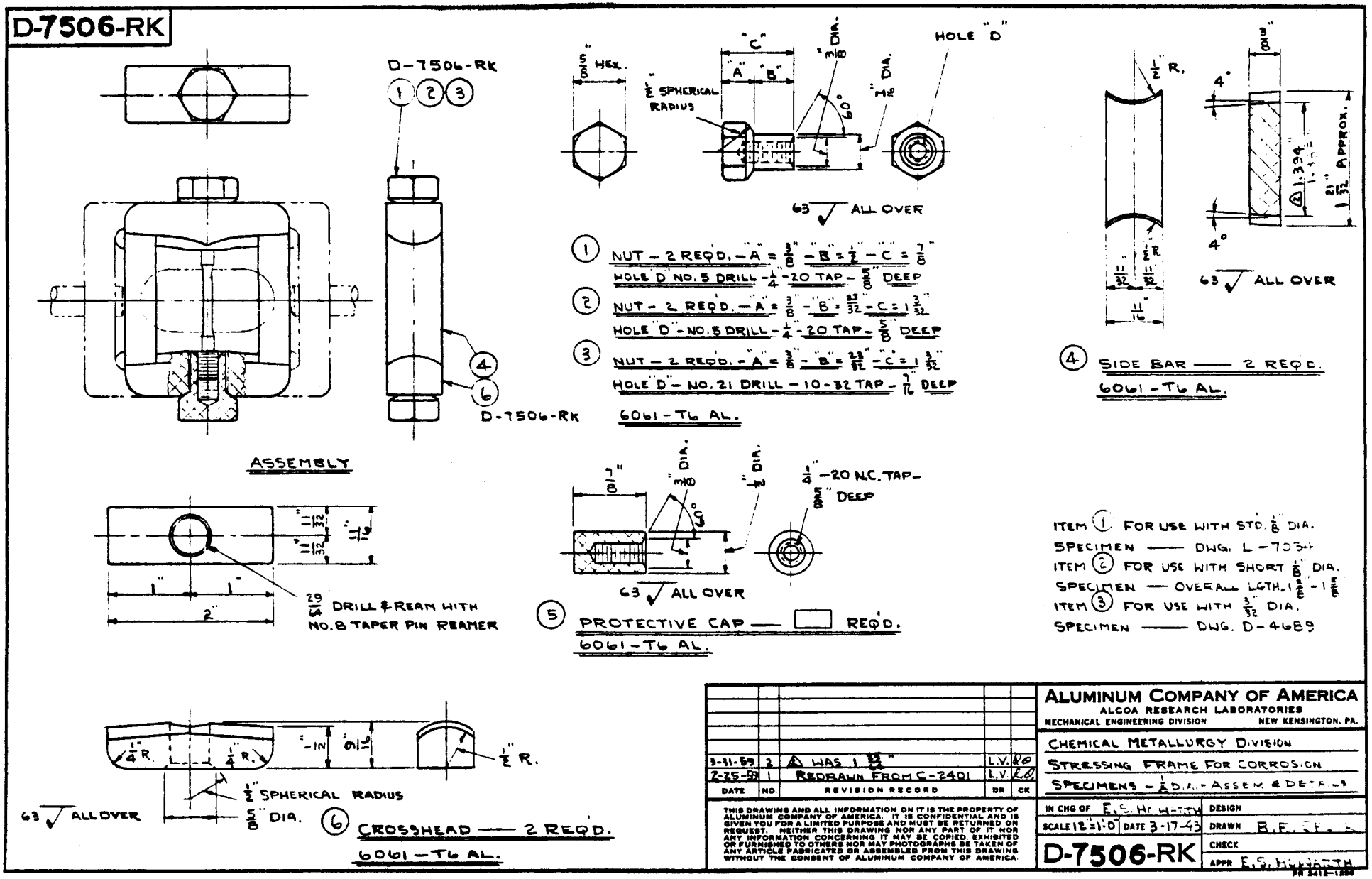
ALUMINUM COMPANY OF AMERICA
ALCOA RESEARCH LABORATORIES
MECHANICAL ENGINEERING DIVISION — NEW KENSINGTON, PA.

MECHANICAL TESTING DIVISION
1/8-DIA. THREADED END TENSILE SPECIMEN — DETAILS

IN CHG OF E. S. HOWARTH	DESIGN
SCALE 24=1'-0 / DATE 1-15-58	DRAWN R. McCLELLAN
L-7034-RK	CHECK R. J. Schumacher
	APPR E. S. Howarth

PR 3412-1256

Figure 2


D-7506-RK
D-7506-RK
1 2 3
4
6
D-7506-RK
ASSEMBLY
HEX.
"C"
"A"
"B"
SPHERICAL RADIUS
DIA.
60°
HOLE "D"
63 ALL OVER
1 NUT – 2 REQ'D. – "A" = 3/8" – "B" = 1/2" – "C" = 7/8"
HOLE "D" NO. 5 DRILL – 1/4"-20 TAP – 5/8" DEEP
2 NUT – 2 REQ'D. – "A" = 3/8" – "B" = 23/32" – C = 1 3/32"
HOLE "D" – NO. 5 DRILL – 1/4" – 20 TAP – 5/8" DEEP
3 NUT – 2 REQ'D. – "A" = 3/8" – "B" = 23/32" – "C" = 1 3/32"
HOLE "D" – NO. 21 DRILL – 10-32 TAP – 7/16" DEEP
6061-T6 AL.
1/2 R.
4°
1.394"
21/32" APPROX.
63 ALL OVER
4 SIDE BAR — 2 REQ'D.
6061-T6 AL.
DRILL & REAM WITH NO. 8 TAPER PIN REAMER
1/4"-20 N.C. TAP-
DEEP
63 ALL OVER
5 PROTECTIVE CAP — REQ'D.
6061-T6 AL.
ITEM 1 FOR USE WITH STD. 1/8" DIA.
SPECIMEN — DWG. L-7034
ITEM 2 FOR USE WITH SHORT 1/8" DIA.
SPECIMEN — OVERALL LGTH. 1 3/16" - 1 1/8"
ITEM 3 FOR USE WITH 3/32" DIA.
SPECIMEN — DWG. D-4689
1/4" R.
1/2" SPHERICAL RADIUS
5/8" DIA.
63 ALL OVER
6 CROSSHEAD — 2 REQ'D.
6061-T6 AL.
3-31-59 2 WAS 1 25/32" L.V.
2-25-59 1 REDRAWN FROM C-2401 L.V.
DATE NO. REVISION RECORD DR CK
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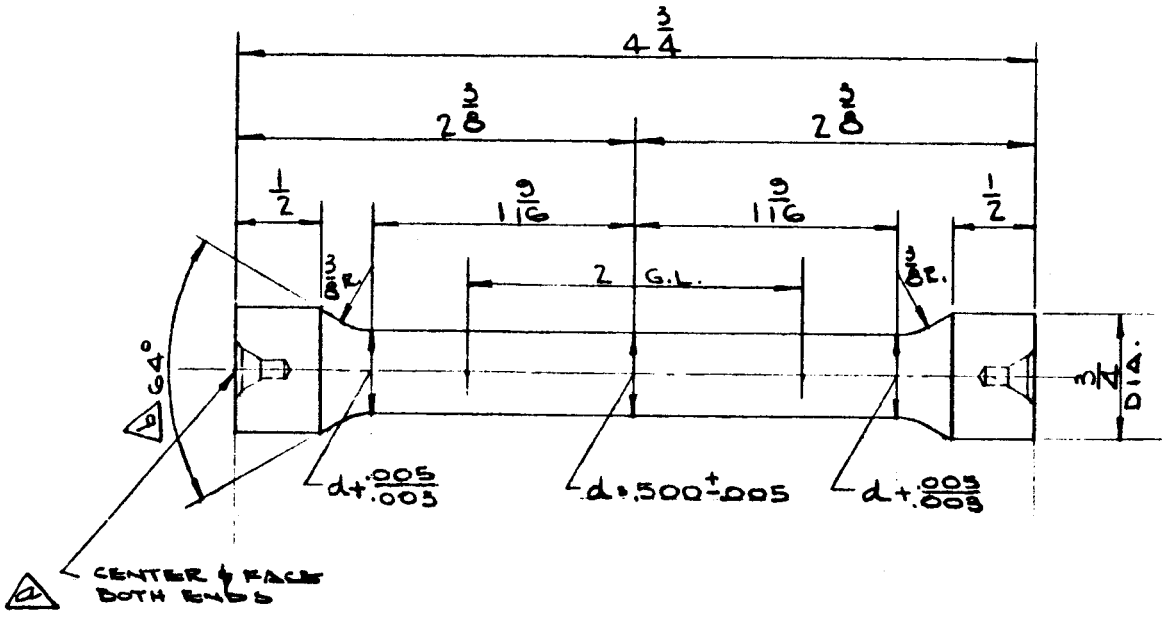
MECHANICAL ENGINEERING DIVISION NEW KENSINGTON, PA.
CHEMICAL METALLURGY DIVISION
STRESSING FRAME FOR CORROSION
SPECIMENS – 1/8" DIA. – ASSEM. & DETAILS
IN CHG OF E.S. HEDWIN DESIGN
SCALE 12"=1'-0" DATE 3-17-43 DRAWN B.F. Stanley
D-7506-RK CHECK
APPR E.S. HEDWIN

Figure 3

L-7735-RK



63 √ ALL OVER

(a) MEETS REQUIREMENT FOR R, SPECIMEN FOR FEDERAL TEST METHODS NO. 211

Note: Break all corners on grip ends by hand for coating purposes.

CENTER ℄ FACING TOOL-1 # 1a	D-7828
DRIVER	D-6987
TEMPLET	D-7736

DATE	NO.	REVISION RECORD	DR	CK
8-24-62	2	(a) WAS 62°	SG	
2-27-62	1	(a) NOTES ADDED	SG	P.Q

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MECHANICAL ENGINEERING DIVISION — NEW KENSINGTON, PA.

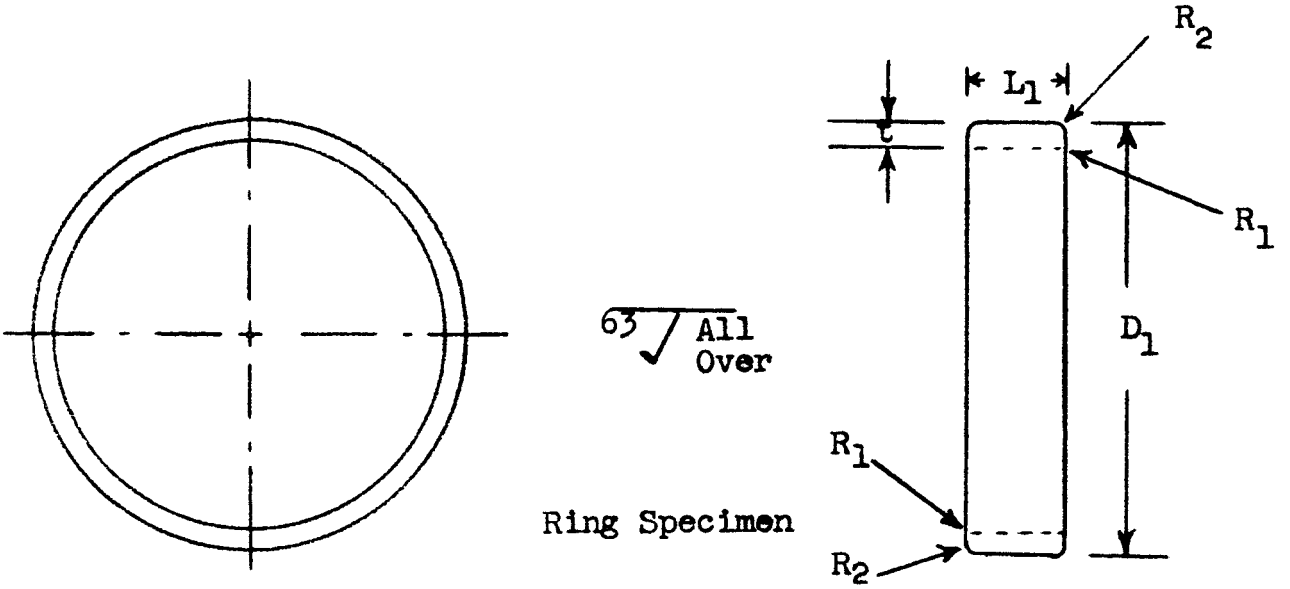
MECHANICAL TEST. DIV.

1/2 DIA TAPERED SEAT TENSILE TEST SPECIMEN

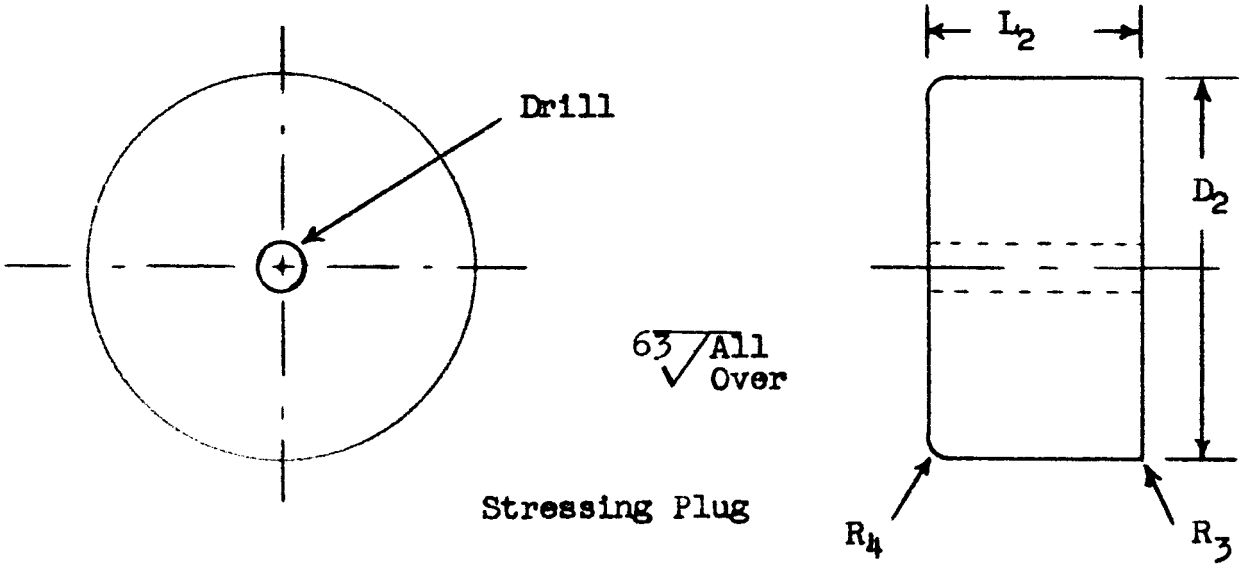
IN CHG OF	DESIGN
SCALE 12:1:0 — DATE 10-27-59	DRAWN H.H.H.
L-7735-RK	CHECK
	APPR

PR 4428-159

Figure 4



Ring Specimen

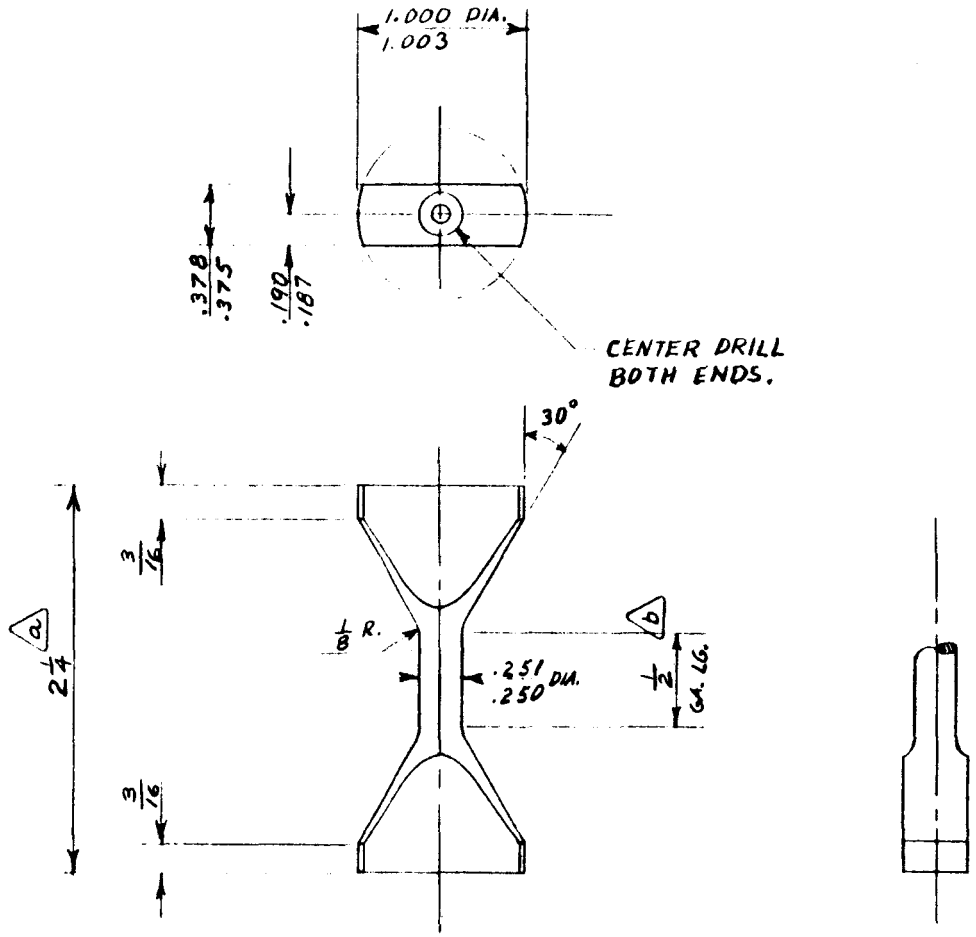


Stressing Plug

Machining Tolerances - Inches	
Ring	Plug
R_1 = 1/64 radius	R_3 = 1/64 radius
R_2 = 1/16 radius	R_4 = 1/8 radius
L_1 = .500 $\pm$ 1/64	L_2 = 1.125 $\pm$ 1/64
D_1 = 2.250 $\pm$ .002	D_2 = ring ID + Int. $\pm$ .0005
t = 0.125 $\pm$ .001	Drill = Size F (.257") for mounting purposes

Figure 5

L-9068-RK



f.a.o. 63 micro-inches

DATE	NO.	REVISION RECORD	DR	CK
6-28-63	1	ⓐ WAS 2 5/16 ⓑ WAS 9/16	MW	

ALUMINUM COMPANY OF AMERICA
ALCOA RESEARCH LABORATORIES
MECHANICAL ENGINEERING DIVISION — NEW KENSINGTON, PA.

PHYSICAL METALLURGY DIV.

REVISED TORSION SPECIMEN

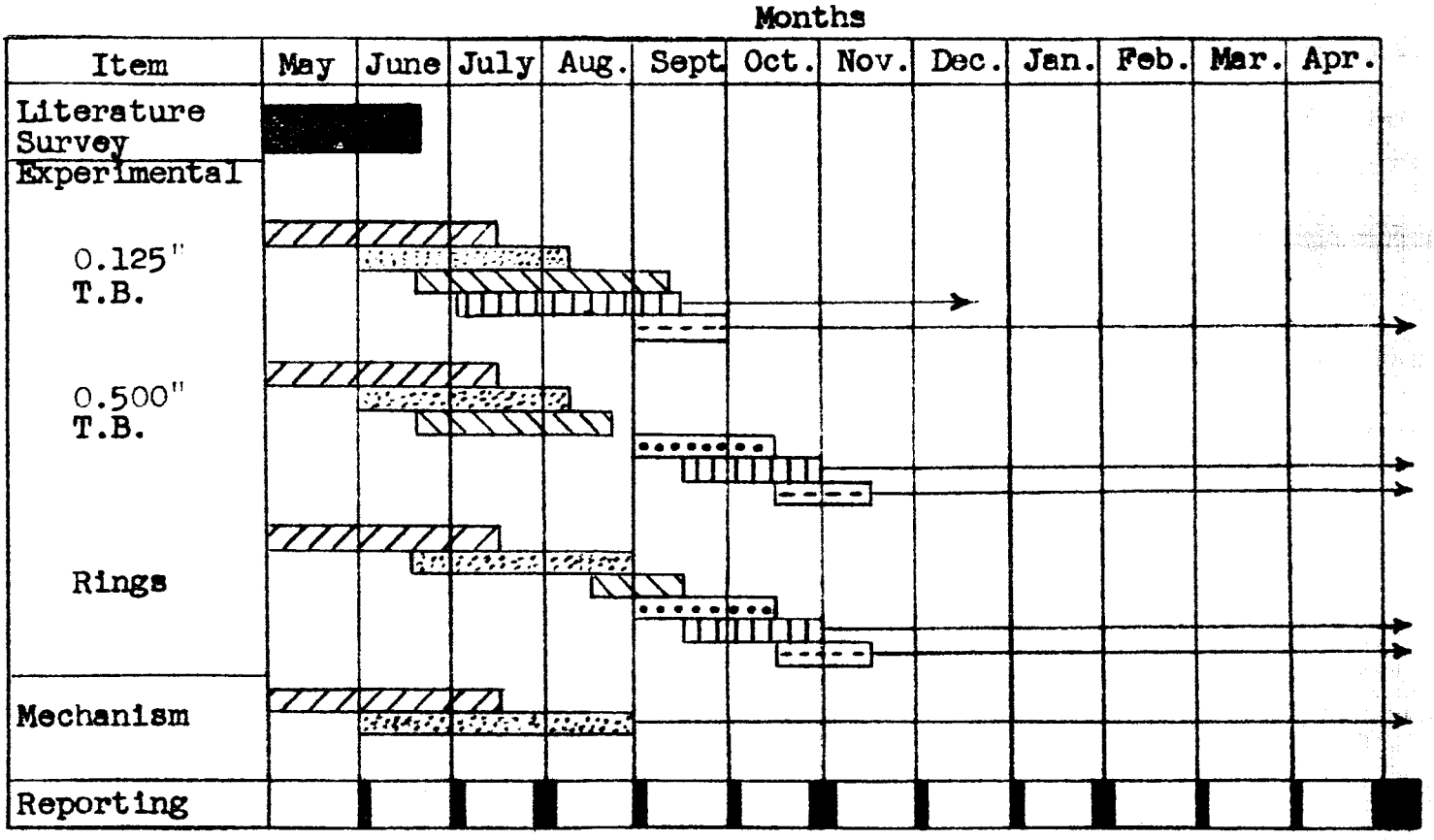
SPECIMEN

IN CHG OF S.C. HUDDLESTON	DESIGN MW
SCALE 12"=1'0" DATE 5-28-63	DRAWN MW
L-9068-RK	CHECK
	APPR

PR 4428-150

Figure 6

ESTIMATED PROGRAM SCHEDULE



Key		Remarks
	Procurement	9 of the 11 items received as of 6-21-63 7006-T651 received 7-18-63 7075-T73 received 7-29-63
	Machining	
	Stressing and/or Measuring	1/8" bars for A.I. to be stressed piecemeal all other specimens to be stressed en masse
	Coating	All specimens for a given treatment to be coated simultaneously
	Exposing (3.5% NaCl - A.I.)	1/8" bars exposed piecemeal as prepared coated specimens of a given surface treatment exposed simultaneously
	Exposing (Atmospheres)	All 1/8" bars exposed simultaneously All coated specimens exposed simultaneously
	In Test	

Figure 7